CLAIMS

What is claimed is:

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       1.   A light emitting apparatus comprising:

            at least one light source;

            a fractal medium; and

            a microcavity, wherein said medium is located in the vicinity of said

10   microcavity.

       2.   The light emitting apparatus of claim 1 wherein said medium comprises aggregated nanoparticles comprising fractals.

15   3.   The light emitting apparatus of claim 1 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

       4.   The light emitting apparatus of claim 1 wherein said microcavity comprises a solid

20   microcavity, and said medium is embedded within said solid microcavity.

       5.   The light emitting apparatus of claim 1 wherein said microcavity comprises a hollow microcavity, and said medium is located within said hollow microcavity.

25   6.   The light emitting apparatus of claim 1 wherein said medium comprises individual nanoparticles each of an average diameter that is less than the optical wavelength of interest.

7.   The light emitting apparatus of claim 1 wherein said microcavity comprises an exterior dimension that is at least twice that of the optical wavelength of interest.

8.   The light emitting apparatus of claim 1 further comprising at least one molecule selected from the group consisting of optically active organic and inorganic molecules, adsorbed on a surface of said nanoparticles.

9.   The light emitting apparatus of claim 8 wherein said at least one molecule comprises at least one molecule selected from the group consisting of laser dye and sodium citrate molecules.

10.   The light emitting apparatus of claim 1 further comprising at least one molecule selected from the group consisting of optically active organic and inorganic molecules, located within the light wavelength of the surface of said nanoparticles.

11.   The light emitting apparatus of claim 10 wherein said at least one molecule comprises at least one molecule selected from the group consisting of laser dye and sodium citrate molecules.

12.   A method of enhancing the optical emission of a material comprising the steps of:

         a)   providing a fractal medium;

         b)   doping the medium with the material;

         c)   locating the doped medium in the vicinity of a microcavity; and

         d)   exciting the doped medium with at least one light source.

13.   The method of claim 12 wherein the providing step comprises providing aggregated nanoparticles comprising fractals.

-74-

14. The method of claim 12 wherein the providing step comprises providing a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

5   15. The method of claim 12 wherein doping the medium with the material comprises doping with at least one material selected from the group consisting of a single molecule, a plurality of molecules, a nanocrystal, a solid matrix, DNA, DNA fragments, amino acids, antigen, antibodies, bacteria, bacterial spores, and viruses.

10   16. The method of claim 12 wherein the locating step comprises embedding the medium within a solid microcavity.

17. The method of claim 12 wherein the locating step comprises locating the medium within a hollow microcavity.

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18. The method of claim 12 wherein the step of doping further comprises doping with at least one molecule selected from the group consisting of optically active organic and inorganic molecules located within the light wavelength of the surface of the medium.

20   19. The method of claim 18 wherein the at least one molecule comprises at least one molecule selected from the group consisting of laser dye and sodium citrate molecules.

20. An amplifying apparatus having a gain greater than 1.2, said apparatus comprising:

at least one light source;

25   a microcavity; and

a fractal medium, said medium located in the vicinity of said microcavity.

21.	The amplifying apparatus of claim 20 wherein said medium comprises aggregated nanoparticles comprising fractals.

22.	The amplifying apparatus of claim 20 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

23.	A method of amplification comprising the steps of:

a)	providing a fractal medium;

b)	locating the medium in the vicinity of a microcavity to amplify optical emission; and

c)	exciting the medium with at least one light source.

24.	The method of claim 23 wherein the providing step comprises providing aggregated nanoparticles comprising fractals.

25.	The method of claim 23 wherein the providing step comprises providing a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

26.	A wavelength translation apparatus comprising:

at least one light source;

a fractal medium; and

a microcavity, wherein said medium is located in the vicinity of said microcavity.

27.   The wavelength translation apparatus of claim 26 wherein said medium comprises aggregated nanoparticles comprising fractals.

28.   The wavelength translation apparatus of claim 26 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

29.   A method of wavelength translation comprising the steps of:

a)   providing a fractal medium;

b)   locating the medium in the vicinity of a microcavity; and

b)   exciting the medium with at least one light source.

30.   The method of claim 29 wherein the providing step comprises providing aggregated nanoparticles comprising fractals.

31.   The method of claim 29 wherein the providing step comprises providing a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

32.   The method of claim 29 wherein locating the medium in the vicinity of a microcavity further comprises amplifying optical emissions via at least one process selected from the group of processes consisting of stimulated emission of photons, stimulated Raman scattering, stimulated hyper-Raman scattering, stimulated Brouillon scattering, optical parametric amplification, multi-photon emission, four-wave mixing, and phase conjugation.

33.   An optical parametric oscillator comprising:

at least one light source;

a cavity; and

a fractal medium, said medium located in the vicinity of said cavity.

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34.   The optical parametric oscillator of claim 33 wherein said medium comprises aggregated nanoparticles comprising fractals.

35.   The optical parametric oscillator of claim 33 wherein said medium comprises a

10   semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

36.   The optical parametric oscillator of claim 33 wherein said cavity comprises a microcavity.

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37.   A light detection and ranging system comprising:

a transmitter light source;

a receiver to receive light produced from the interaction of the transmitter

light with constituents;

20   a fractal medium; and

a microcavity, wherein said medium is located in the vicinity of said

microcavity to amplify the received light.

38.   The light detection and ranging system of claim 37 wherein said medium comprises

25   aggregated nanoparticles comprising fractals.

39. The light detection and ranging system of claim 37 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

40. A method of optical data storage comprising the steps of:

a) providing a fractal medium;

b) locating the medium in the vicinity of a microcavity;

c) irradiating the medium with polychromatic light; and

d) generating hot spots in the medium due to intensity differences of different wavelengths, and spectral hole burning the medium due to photomodification, thereby creating high density storage capabilities.

41. The method of claim 40 wherein the providing step comprises providing aggregated nanoparticles comprising fractals.

42. The method of claim 40 wherein the providing step comprises providing a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

43.   A method of detecting a material, wherein the material is a material selected from the group consisting of chemical compounds and biological materials, using near-field optical spectroscopy, the method comprising the steps of:

a)   providing a fractal medium;

5   b)   exciting both the material and the medium with at least one light source;

c)   locating the material within a distance shorter than the light wavelength from a near-field optical detector; and

d)   recording spectroscopic data of the material.

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44.   The method of claim 43 wherein the providing step comprises providing aggregated nanoparticles comprising fractals.

45.   The method of claim 43 wherein the providing step comprises providing a

15   semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

46.   The method of claim 43 further comprising the step of locating the medium in the vicinity of a microcavity.

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47.   The method of claim 46 wherein the exciting step further comprises exciting the microcavity.

48.   The method of claim 43 further comprising the step of adsorbing the material on the

25   surface of the medium.

49.   The method of claim 43 further comprising the step of depositing the medium onto the detector.

5   50.   The method of claim 43 wherein the locating step comprises locating the material within a distance shorter than the light wavelength from the input end of an optical fiber.

51.   The method of claim 50 wherein in the locating step the input end is tapered.

10   52.   The method of claim 43 wherein the locating step comprises locating the material within a distance shorter than the light wavelength from a sharp tip of a vibrating metal wire.

53.   The method of claim 43 wherein the exciting step comprises exciting both the material and the medium with a light source through an optical fiber.

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54.   The method of claim 53 wherein the exciting step comprises exciting both the material and the medium with a light source through an end of an optical fiber.

55.   The method of claim 54 wherein in the exciting step the end of the optical fiber is

20   tapered.

56.   The method of claim 54 wherein the exciting step further comprises locating the end of the optical fiber within a distance shorter than the light wavelength from the material.

25   57.   The method of claim 43 wherein recording spectroscopic data comprises recording at least one data selected from the group consisting of electronic, vibrational, and rotational spectroscopy data of the material.

58.   The method of claim 43 further comprising the step of doping the medium with the material.

5   59.   An optical sensing enhancing material comprising:

a fractal medium; and

a microcavity, wherein said medium is located in a vicinity of said microcavity.

10   60.   The optical sensing enhancing material of claim 59 wherein said medium comprises aggregated nanoparticles comprising fractals.

61.   The optical sensing enhancing material of claim 59 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at

15   approximately their percolation threshold.

62.   A method of making an optical sensing enhancing material, the method comprising the steps of:

providing a microcavity; and

20   locating a fractal medium in a vicinity of the microcavity.

63.   The method of claim 62 wherein the locating step comprises locating aggregated nanoparticles comprising fractals in a vicinity of the microcavity.

25   64.   The method of claim 62 wherein the locating step comprises locating a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold in a vicinity of the microcavity.

65. An optical sensor comprising:

a fractal medium;

a microcavity, wherein said medium is located in a vicinity of said

5 microcavity;

a light source incident on said medium; and

a detector of light reflected from said medium.

66. The optical sensor of claim 65 wherein said medium comprises aggregated

10 nanoparticles comprising fractals.

67. The optical sensor of claim 65 wherein said medium comprises a semicontinuous

metal film of randomly distributed metal particles and their clusters at approximately their percolation

threshold.

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68. The optical sensor of claim 65 wherein at least one analyte is placed in direct contact

with said medium.

69. The optical sensor of claim 65 wherein at least one analyte is remote from said

20 medium.

70. The optical sensor of claim 65 wherein said light source comprises two

counterpropogating light sources.

25 71. The optical sensor of claim 65 wherein said microcavity is selected from the group

consisting of quartz tubes and quartz rods.

72.   An optical sensing method comprising the steps of:

providing a doped fractal medium with a material;

locating the doped medium in the vicinity of a microcavity;

exciting the doped medium with a light source; and

5   detecting light reflected from said doped medium.

73.   The method of claim 72 wherein in the providing step the medium comprises aggregated nanoparticles comprising fractals.

10   74.   The method of claim 72 wherein in the providing step the medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

75.   The optical sensing method of claim 72 additionally comprising the step of placing at 15   least one analyte in direct contact with the doped medium.

76.   The optical sensing method of claim 72 additionally comprising the step of locating at least one analyte remotely from the medium.

20   77.   The optical sensing method of claim 72 wherein in the exciting step the light source comprises two counterpropogating light sources.

78.   The optical sensing method of claim 72 wherein in the locating step the microcavity is selected from the group consisting of quartz tubes and quartz rods.

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79.   A method of detecting a material, the method comprising the steps of:

exciting both the material and a fractal medium in a vicinity of a microcavity

with at least one light source; and

detecting spectroscopic data of the material.

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80.   The method of claim 79 wherein in the exciting step the medium comprises

aggregated nanoparticles comprising fractals.

81.   The method of claim 79 wherein in the exciting step the medium comprises a

10   semicontinuous metal film of randomly distributed metal particles and their clusters at approximately

their percolation threshold.

82.   An optical enhancing material comprising a fractal medium and a microcavity.

15   83.   The optical enhancing material of claim 82 wherein said medium comprises

aggregated nanoparticles comprising fractals.

84.   The optical enhancing material of claim 82 wherein said medium comprises a

semicontinuous metal film of randomly distributed metal particles and their clusters at approximately

20   their percolation threshold.

85.   The material of claim 84 wherein said metal comprises at least one metal selected

from the group consisting of silver, gold, copper, platinum, nickel, and aluminum.

25   86.   The material of claim 84 wherein said metal particles have an average width

between approximately 1 and 1000 nanometers.

87.   The material of claim 84 wherein said metal particles and their clusters have lengths varying from the widths of individual metal particles to a lateral size of the metal film.

88.   The material of claim 84 wherein said semicontinuous metal film has an average

5   thickness between approximately 1 and 100 nanometers.

89.   The material of claim 84 wherein said semicontinuous metal film has a metal-filling factor p over a range between $p_c - (\varepsilon_{\text{dielectric}} / |\varepsilon_{\text{metal}}|)^{0.36}$ and $p_c + (\varepsilon_{\text{dielectric}} / |\varepsilon_{\text{metal}}|)^{0.36}$, where p_c is a metal-filling factor at the percolation threshold, $\varepsilon_{\text{dielectric}}$ is a dielectric function, permittivity, of a

10   dielectric component of the semicontinuous metal film, and $\varepsilon_{\text{metal}}$ is a dielectric function, permittivity, of a metal component of the semicontinuous metal film.

90.   The material of claim 84 wherein said semicontinuous metal film is manufactured with at least one method selected from the group consisting of ion exchange, thermal evaporation,

15   pulsed laser deposition, laser ablation, electron-beam deposition, ion-beam deposition, sputtering, radio-frequency glow discharge, and lithography.

91.   The material of claim 82 wherein said material provides optical enhancement at light wavelengths between approximately 10 and 100,000 nanometers.

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92.   The material of claim 91 wherein said material provides optical enhancement at light wavelengths between approximately 200 and 20,000 nanometers.

93.   The material of claim 82 additionally comprising an analyte placed proximate said

25   medium.

94.   The material of claim 94 wherein said analyte comprises at least one analyte selected from the group consisting atoms, molecules, nanocrystals, nanoparticles, and biological materials.

5   95.   The material of claim 93 wherein said analyte is chiral.

        96.   The material of claim 93 additionally comprising a non-reactive surface coating placed over a component selected from the group consisting of said analyte, said medium, and both.

10   97.   The material of claim 82 wherein said microcavity comprises one or more materials selected from the group consisting of dielectric and semiconductor materials.

        98.   The material of claim 82 wherein said microcavity is selected from the group consisting of spheres, deformed spheres, spheroids, rods, and tubes.

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        99.   The material of claim 82 wherein said microcavity is a semiconductor laser cavity.

        100.   The material of claim 82 wherein said medium is located at one or more surfaces of said microcavity selected from the group consisting of inner and outer surfaces.

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        101.   The material of claim 82 wherein said medium is an integrated component of said microcavity.

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102.   An optical sensor comprising:

a fractal medium;

a microcavity;

a light source incident on said medium; and

5   one or more detectors of light emitted from said medium.

103.   The optical sensor of claim 102 wherein said medium comprises aggregated nanoparticles comprising fractals.

10   104.   The optical sensor of claim 102 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

105.   The optical sensor of claim 102 wherein said detector detects at least one signal

15   selected from the group consisting of fluorescence, spontaneous emission, Raman scattering, Rayleigh scattering, Brillouin scattering, and nonlinear optical processes selected from the group consisting of stimulated Raman scattering, hyper-Raman scattering, hyper-Rayleigh scattering, multi-photon anti-Stokes emission, harmonic generation, sum-frequency generation, difference-frequency generation, optical parametric processes, multi-photon absorption, three- and four-wave mixing, and

20   phase conjugation.

106.   An optical sensing method comprising the steps of:

providing a doped fractal medium;

locating the doped fractal medium proximate a medium;

25   employing a microcavity;

exciting the doped fractal medium with a light source; and

detecting light emitted from said doped fractal medium.

107.   The method of claim 106 wherein in the providing step the fractal medium comprises aggregated nanoparticles comprising fractals.

5   108.   The method of claim 106 wherein in the providing step the fractal medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

109.   The optical sensing method of claim 106 wherein said detecting step comprises

10   detecting at least one signal selected from the group consisting of fluorescence, spontaneous emission, Raman scattering, Rayleigh scattering, Brillouin scattering, and nonlinear optical processes selected from the group consisting of stimulated Raman scattering, multi-photon anti-Stokes emission, hyper-Raman scattering, hyper-Rayleigh scattering, harmonic generation, sum-frequency generation, difference-frequency generation, optical parametric processes, multi-photon absorption,

15   three- and four-wave mixing, and phase conjugation.

110.   A method of detecting an analyte material, the method comprising the steps of:
        employing a microcavity;   .
        exciting both the analyte material and a fractal medium in a vicinity of the

20   analyte material with at least one light source; and
        detecting light emitted from the material and medium.

111.   The method of claim 110 wherein in the exciting step the medium comprises aggregated nanoparticles comprising fractals.

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112. The method of claim 110 wherein in the exciting step the medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

5   113. The method of claim 110 wherein said detecting step comprises detecting at least one signal selected from the group consisting of fluorescence, spontaneous emission, Raman scattering, Rayleigh scattering, Brillouin scattering, and nonlinear optical processes selected from the group consisting of stimulated Raman scattering, multi-photon anti-Stokes emission, hyper-Raman scattering, hyper-Rayleigh scattering, harmonic generation, sum-frequency generation, difference-

10   frequency generation, optical parametric processes, multi-photon absorption, three- and four-wave mixing, and phase conjugation.

114. The method of claim 110 wherein the analyte material is selected from the group consisting of atoms; molecules; nanoparticles; chemical agents in water and atmosphere; biological

15   agents in water and atmosphere; contaminations and environment hazards in the air, in water, in soil, at or near manufacturing sites, or at waste dumps; explosives; controlled substances; residual chemicals in foods; food poison; and chemical and biological agents in a body, bodily fluids, and wastes of humans and animals.

20   115. The method of claim 114 additionally wherein said molecules comprise chiral molecules.

116. A gratingless spectrometer comprising:

a fractal medium;

25   a microcavity;

a light source incident on said medium; and

one or more near-field detectors of light emitted from said medium.

117.   The gratingless spectrometer of claim 116 wherein said medium comprises aggregated nanoparticles comprising fractals.

5   118.   The gratingless spectrometer of claim 116 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

119.   A gratingless spectroscopy method comprising the steps of:

10   providing a fractal medium;

locating the fractal medium in the vicinity of a microcavity;

exciting the medium with a light source; and

detecting light emitted from said doped medium in the near-field zone.

15   120.   The method of claim 119 wherein in the providing step the medium comprises aggregated nanoparticles comprising fractals.

121.   The method of claim 119 wherein in the providing step the medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately

20   their percolation threshold.

122.   A device for cryptography, coding and decoding information, said device comprising:

a fractal medium;

a light source incident on said medium;

25   one or more near-field detectors of light emitted from said medium; and

a logic component that compares a detected light pattern with an expected

pattern.

123. The device of claim 122 wherein said medium comprises aggregated nanoparticles comprising fractals.

5   124. The device of claim 122 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

125. The device of claim 122 further comprising a microcavity.

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126. A method for cryptography, coding and decoding information, the method comprising the steps of:

     providing a fractal medium;

     exciting the medium with a light source;

15   detecting light emitted from said medium in the near-field zone; and

     comparing a detected light pattern with an expected pattern.

127. The method of claim 126 wherein in the providing step the medium comprises aggregated nanoparticles comprising fractals.

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128. The method of claim 126 wherein in the providing step the medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

25   129. The method of claim 126 further comprising the step of providing a microcavity.

130.   An enhanced optical limiting material comprising:

a fractal medium;

a microcavity; and

an optical limiting material placed proximate the fractal medium.

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131.   The material of claim 130 wherein said medium comprises aggregated nanoparticles comprising fractals.

132.   The material of claim 130 wherein said medium comprises a semicontinuous metal

10   film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

133.   An enhanced optical limiting device comprising:

a fractal medium;

15   a microcavity; and

an optical limiting material placed proximate the medium.

134.   The device of claim 133 wherein said medium comprises aggregated nanoparticles comprising fractals.

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135.   The device of claim 133 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

136.   A microlaser comprising:

a fractal medium;

an optically active material;

an energy source applied to said medium and said optically active material;

and

a microcavity.

137.   The microlaser of claim 136 wherein said medium comprises aggregated

nanoparticles comprising fractals.

138.   The microlaser of claim 136 wherein said medium comprises a semicontinuous

metal film of randomly distributed metal particles and their clusters at approximately their percolation

threshold.

139.   An optical amplifier comprising:

a fractal medium;

a microcavity; and

a light source incident on said medium.

140.   The optical amplifier of claim 139 wherein said medium comprises aggregated

nanoparticles comprising fractals.

141.   The optical amplifier of claim 139 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

5   142.   The optical amplifier of claim 139 additionally comprising a layer of coating material selected from the group consisting of molecules, nanocrystals, and nanoparticles placed proximate said medium.

143.   An optical amplification method comprising the steps of:

10   providing a fractal medium;

                providing a microcavity;

                providing an input signal; and

                exciting the medium with a light source.

15   144.   The method of claim 143 wherein the step of providing a fractal medium comprises providing aggregated nanoparticles comprising fractals.

145.   The method of claim 143 wherein in the step of providing a fractal medium comprises providing a semicontinuous metal film of randomly distributed metal particles and their

20 clusters at approximately their percolation threshold.

146.   The optical amplification method of claim 40 additionally comprising the step of providing a layer of coating material selected from the group consisting of molecules, nanocrystals, and nanoparticles placed proximate the medium.

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147. An optical switch comprising:

a fractal medium;

a microcavity; and

a light source incident on said medium.

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148. The optical switch of claim 147 wherein said medium comprises aggregated nanoparticles comprising fractals.

149. The optical switch of claim 147 wherein said medium comprises a semicontinuous

10 metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

150. The optical switch of claim 147 additionally comprising a layer of optical switching material selected from the group consisting of molecules, nanocrystals, and nanoparticles placed

15 proximate the medium.

151. An optical switching method comprising the steps of:

providing a fractal medium;

providing a microcavity;

20 providing an input signal; and

exciting the medium with a light source.

152. The method of claim 151 wherein the step of providing a fractal medium comprises providing aggregated nanoparticles comprising fractals.

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153.   The method of claim 151 wherein in the step of providing a fractal medium

comprises providing a semicontinuous metal film of randomly distributed metal particles and their

clusters at approximately their percolation threshold.

5   154.   The optical switching method of claim 151 additionally comprising the step of

providing a layer of coating material selected from the group consisting molecules, nanocrystals, and

nanoparticles placed proximate the medium.

        155.   A super density optical recording device comprising:

10   a fractal medium;

                        a layer of photosensitive materials placed proximate said medium;

                        a light source incident on said medium; and

                        one or more near-field detectors of light emitted from said medium and said

layer of photosensitive materials.

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        156.   The device of claim 155 wherein said medium comprises aggregated nanoparticles

comprising fractals.

        157.   The device of claim 155 wherein said medium comprises a semicontinuous metal

20   film of randomly distributed metal particles and their clusters at approximately their percolation

threshold.

158.   The device of claim 155 further comprising a microcavity.

159.   A super density optical recording method comprising the steps of:

providing a fractal medium;

5   providing a layer of photosensitive materials placed proximate the medium;

exciting the medium and photosensitive materials with a light source; and

detecting light emitted from said medium and photosensitive materials in a

near-field zone.

10   160.   The method of claim 159 wherein the step of providing a fractal medium comprises

providing aggregated nanoparticles comprising fractals.

161.   The method of claim 159 wherein in the step of providing a fractal medium

comprises providing a semicontinuous metal film of randomly distributed metal particles and their

15   clusters at approximately their percolation threshold.

162.   The method of claim 159 further comprising the step of providing a microcavity.

163.   A photochemical enhancing device comprising:

20   a fractal medium;

a microcavity; and

a photochemical agent placed proximate said medium.

164.   The device of claim 163 wherein said medium comprises aggregated nanoparticles

25   comprising fractals.

165.   The device of claim 163 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

5   166.   The device of claim 163 additionally comprising a highly porous dielectric matrix.

167.   A photochemical enhancing method comprising the steps of:

        providing a fractal medium;

        locating the medium in the vicinity of a microcavity;

10   .   providing a photochemical agent placed proximate the medium; and

        exciting the medium and photochemical agent with a light source.

168.   The method of claim 167 wherein the step of providing a fractal medium comprises providing aggregated nanoparticles comprising fractals.

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169.   The method of claim 167 wherein in the step of providing a fractal medium comprises providing a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

20   170.   The method of claim 167 additionally comprising the step of providing a highly porous dielectric matrix.

171.   A photobiological enhancing device comprising:

        a fractal medium;

25   a microcavity; and

        a photobiological agent placed proximate said medium.

172.   The device of claim 171 wherein said medium comprises aggregated nanoparticles comprising fractals.

173.   The device of claim 171 wherein said medium comprises a semicontinuous metal

5   film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

174.   The device of claim 171 additionally comprising a highly porous dielectric matrix.

10   175.   A photobiological enhancing method comprising the steps of:

        providing a fractal medium;

        providing a microcavity;

        providing a photobiological agent placed proximate the medium; and

        exciting the medium and photobiological agent with a light source.

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176.   The method of claim 175 wherein the step of providing a fractal medium comprises providing aggregated nanoparticles comprising fractals.

177.   The method of claim 175 wherein in the step of providing a fractal medium

20   comprises providing a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

178.   The method of claim 175 additionally comprising the step of providing a highly porous dielectric matrix.

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179.   A sub-femtosecond pulse generation device comprising:

a fractal medium;

a microcavity;

a light source incident on said medium; and

5   one or more near-field detectors of light emitted from said medium.

180.   The device of claim 179 wherein said medium comprises aggregated nanoparticles comprising fractals.

10   181.   The device of claim 179 wherein said medium comprises a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

182.   The device of claim 179 wherein said light source is selected from the group of

15 femtosecond pulses and white-light,

183.   A method of generation of sub-femtosecond pulses comprising the steps of:

providing a fractal medium;

providing a microcavity;

20   exciting the medium with a light source; and

detecting the sub-femtosecond pulses using one or more near-field

detectors.

184.   The method of claim 183 wherein the step of providing a fractal medium comprises

25 providing aggregated nanoparticles comprising fractals.

185.   The method of claim 183 wherein in the step of providing a fractal medium comprises providing a semicontinuous metal film of randomly distributed metal particles and their clusters at approximately their percolation threshold.

5   186.   The method of claim 183 wherein in the exciting step the light source is selected from the group of femtosecond pulses and white-light.